EXHIBIT 24

Form 229

Milwaukee Solvay Coke Company

REPORT ON THE OPERATIONS OF

MILWAUKEE SOLVAY COKE COMPANY

Chas. R. Hetherington & Co., Ltd.

June 1959

C O N T E N T S

Letter of transmittal

Report Introduction 1

Section 1: The Operations of the Milwaukee Solvay Coke Company

The Coke Company Plant 4

Coke Oven Gas Production and Sale
The Coke Oven Gas Contract 8
Coke Oven Gas Yield 12
Economics of Standby Operation 17

Other Plant Operations
Operating Practices 19
By-Product Yields 23
Firing Alternate Fuels and Power Generation 25

Maintenance and Plant Condition 33

Section 2: The Future Sale of Coke Oven Gas Between The Coke Company and the Gas Company

Prior to Termination of the Coke Oven Gas Contract 35

(Coke Oven Gas for Spaceheating 37)

CHARTS

Chart No. 1 - Coke Plant Capacity at Various Coking Times.

Chart No. 2 - Surplus Coke Oven Gas Production and Heating Value at Various Coking Times.

Chart No. 3 - Steam and Electric Power Requirements for the Coke Plant.

Chart No. 4 - Boiler House Incremental Operating and Repair Costs.

TABLES (Not included in this report)

Table No. 1 - Coal Carbonized and Coke Oven Gas Production.

Table No. 2 - Variation in Coke Oven Gas Composition With Coking Time.

Table No. 3 - Availability of Surplus Coke Oven Gas by Months.

Table No. 4 - Producer and Petroleum Plant Standby Costs - Year 1958.

Table No. 5 - Coke Yield from Coal and The Distribution of Various Coke Sizes.

Table No. 6 - Operating Labor with Two-Shift and Three-Shift Operation.

Table No. 7 - Cost of Labor in the Coke Handling Department With Two-Shift and Three-Shift Operation When Reclaiming Coke from Stor age.

Table No. 8 - Actual Premium Time Paid by The Coke Plant.

Table No. 9 - Coal Chemical By-Product Prices Received by The Coke Plant.

Table No.10 - Comparison of Costs which Vary With Type of Fuel Fired and Electric Generation.

PLOT PLAN

SECTION 1

THE OPERATIONS OF

THE MILWAUKEE SOLVAY COKE COMPANY

REPORT ON THE OPERATIONS
OF MILWAUKEE SOLVAY COKE COMPANY

June 1, 1959

INTRODUCTION

The Milwaukee Solvay Coke Company (hereinafter referred to as the Coke Company), a subsidiary of the American Natural Gas Company system and thereby an affiliate of the Milwaukee Gas Light Company (hereinafter referred to as the Gas Company), owns a merchant coke plant located on deep water within the City of Milwaukee, Wisconsin, for the production of coke, coke oven gas and coal chemicals. Coke oven gas is sold to the Gas Company and, prior to the advent of natural gas in 1949, was a principal source of gas supply for the Gas Company. The Coke Company has been in operation for over 50 years and the management has had to alter its operations and policies to meet a wide variety of varying conditions over the years.

With the advent of natural gas to Milwaukee, supplied by Michigan Wisconsin Pipe Line Company (hereinafter referred to as Michigan Wisconsin, also a subsidiary of the American Natural Gas Company system), the Gas Company in its desire to avoid the distribution of mixed coke oven and natural gas worked out a ten-year arrangement to sell all of the coke oven gas produced by the Coke Company to the Sewerage Commission of the City of Milwaukee, (hereinafter referred to as the Sewerage Commission). A companion contract was entered into between the Coke

Company and the Gas Company (hereinafter referred to as the Coke Oven Gas Contract) for the sale of the coke oven gas to the Gas Company.

Various difficulties have arisen in operating under the Coke Oven Gas Contract and the contract with the Sewerage Commission, and recently the Gas Company has negotiated a more favorable agreement with the Sewerage Commission which will become effective and terminate the old contract as of May 1, 1959, subject to the approval of the Public Service Commission of Wisconsin. The Coke Oven Gas Contract will terminate on September 1, 1960, pursuant to notice given as provided in the contract.

A study has been made of the operations of the Coke Company and of the effect of such operations on the Gas Company to determine (a) if the Coke Company is being operated most effectively, and (b) the most desirable arrangements for the future between the Coke Company and the Gas Company, both until the termination of the Coke Oven Gas Contract in 1960, and thereafter. This report is divided into two sections, dealing with these matters as follows:

Section 1: The Operations of The Milwaukee Solvay Coke Company.

Section 2: The Future Sale of Coke Oven Gas Between The Coke Company and The Gas Company.

Section 1 deals with the following principal subjects:

1. The Coke Company Plant.
2. Coke Oven Gas Production and Sale
   - (a) The Coke Oven Gas Contract
   - (b) Coke Oven Gas Yield
   - (c) Economics of Standby Operation
3. Other Plant Operations
   - (a) Operating Practices
   - (b) By-Product Yields
   - (c) Firing Alternate Fuels and Power Generation
4. Maintenance and Plant Condition

Conclusions and recommendations are summarized in the letter of transmittal for this report.

THE COKE COMPANY PLANT

The Coke Company plant is located at 311 East Greenfield Avenue on 41.8 acres of land fronting on deep water of the Kinnickinnic River, providing access to Great Lakes and ocean shipping. The plant is served by the Chicago, Milwaukee, St. Paul and Pacific Railway; the Milwaukee, Chicago and Northwestern Railway; and the Chesapeake and Ohio Railway car ferry. A layout of the plant is shown in the attached Plot Plan.

The coking facilities consist of 200 ovens in four batteries. Two of the batteries are of the Solvay type with 40 ovens in one battery and 60 in the other. The other two batteries are of the Koppers type with 50 ovens each. The Koppers ovens are 17-inch ovens with some 30 feet long while the Solvay ovens are 17-inch ovens some 36 feet long, each with a nominal coal charge capacity of eleven tons at a bulk density of 50 pounds per cubic foot. Actual coal charge is about ten tons per oven or 2,000 tons for the plant of 200 ovens. The nominal capacity of the plant is about 2,000 tons per day of coal charge to produce 1600 tons per day of furnace, foundry and other cokes. When operating on foundry coke the plant capacity is 1600 tons per day of coal charge.

The Koppers ovens are equipped with heat regenerators, while the Solvay ovens use recuperative heat recovery in by-product steam generators. The ovens have compound firing and, although coke oven gas is normally fired, the Koppers ovens can

be fired with producer gas while the Solvay ovens can be fired with petroleum-enriched producer gas. There is a producer gas plant with a capacity of 38,000 therms per day and a liquified petroleum gas plant with a capacity of 14,400 therms per day, making a total gas generating capacity of 52,400 therms daily.

The plant is equipped with screens and crushers to provide the sizes desired for foundry and furnace use and the smaller egg, stove, nut, range, pea and breeze.

The gas recovery system consists of facilities to remove and recover crude tar including naphthalene, an ammoniacal water solution which is concentrated to 26% ammonia and light oils which are fractionated into benzol, toluol and mixed xylols. Neither pyridine nor sulphur are recovered. Waste liquor is disposed of to the Sewerage Commission and sulphur is left in the coke oven gas.

The boiler plant consists of eight boilers with a total capacity of 4,000 boiler horsepower, two of which are converted for the firing of gas as well as solid fuels. The power plant consists of three steam engine driven generators, two steam turbine driven generators and a motor generator set with a combined capacity of 3,100 kilowatts of direct current.

The plant is complete with other appurtenant facilities, such as gas holders, gas compressors to transfer the coke oven gas and a water system from the river to provide cooling water and fire protection. As noted on the Plot Plan, the plant site is provided with ample dockage, railway spurs and a 480 foot coal stacking and reclaiming bridge.

The plant, out of necessity due to its age, is equipped with machine shop, pipe shop and other services required to keep the equipment in operation. A railroad system is employed throughout the plant to handle coke movement except for storage and reclaiming of coke which is done by truck.

Coal is received at the plant from April 1st to December 15th and is stacked in individual piles and impacted to protect against spontaneous combustion. Daily needs of coal for processing are transferred from the stock piles by conveyor belt and are proportioned as required by the mix being coked. The coal is weighed, mixed and crushed and then conveyed to the coke oven bins from whence it is charged to the oven chambers by overhead cars.

At present foundry coke is screened into desired sizes and sold. Currently the market is taking all foundry coke production while running at an operating rate of 1,000 tons per day of coal charge, along with additional coke that is being reclaimed from inventory. At times when the market does not absorb all coke production it is loaded into trucks and hauled to a storage area where it is stocked until such time as it is needed. At present some 70% of coke

production is of 3 in. and over foundry quality while the remainder is smaller sizes and breeze which are sold for industrial and domestic purposes.

The gas produced from the coal carbonized is drawn from the ovens by means of exhausters located in the by-products building. This gas is cooled for the extraction of tar, ammonia solution and light oil products. Coke oven gas production is first used for underfiring of the ovens and any surplus is compressed to about 9 lbs. per square inch pressure for delivery to ~~the Sewerage Commission.~~ the boiler house, the surplus delivered to the Sewerage Commission. The Coke Company handles its own sales of domestic coke in Milwaukee County while the other sales, including foundry, furnace, industrial and domestic are handled by the Company's agent, Pickands, Mather & Company. The coal chemicals, ammoniacal liquor, benzol, toluol and xylol are sold through Nitrogen Products, Inc.

COKE OVEN GAS PRODUCTION AND SALE

The Coke Oven Gas Contract:

The Coke Oven Gas Contract of August 22, 1950, under which the Coke Company sells its coke oven gas to the Gas Company obligates the Coke Company to deliver a minimum of 60,000 therms and up to 67,000 therms if available of surplus coke oven gas a day to be paid for at a price per therm equal to the average cost of coal per therm to the Wisconsin Electric Power Company, which price has been running about 3.3¢ per therm.

The Coke Oven Gas Contract also provides that the Coke Company will maintain its producer plant and liquified petroleum gas plant in standby condition so that the Coke Company will be able to deliver during periods of emergency, a total quantity of gas up to 110,000 therms per day. For this standby service the Coke Company receives a standby fee of $100,000 annually.

The Coke Company has experienced the wide fluctuations in market conditions, characteristic of the merchant coke business. Since a merchant coke plant supplies what might be termed peak load coke requirements of the iron and steel industry, such a plant is the first to suffer a reduced market during times of reduced steel production. In addition, since the time of entering into the Coke Oven Gas Contract, the steel companies have built up coking capacity of their own to provide for over 85% of their requirements for furnace coke and accordingly, the market for furnace coke has continually decreased until today, there appears to be little

expectation of any substantial market for this grade of coke, except in case of a national emergency.

The following tabulation indicates the trend in coke sales volume and distribution:

		Annual Sales Tons				
	Year	Furnace	Foundry	Other	Total	Per cent Furnace Coke
	1950	147,622	223,470	141,005	512,097	43.6%
	1951	208,377	236,962	83,003	528,342	39.4
	1952	191,987	227,304	80,825	500,116	38.4
	1953	261,241	214,638	73,330	549,209	47.8
	1954	-	177,442	61,999	239,441	0.0
	1955	170,833	265,539	66,998	503,370	33.9
	1956	57,060	249,555	78,678	385,293	14.8
	1957	94,632	198,959	72,501	366,092	25.9
	1958	33,876	172,022	62,263	268,161	12.6
(3 months)	1959	-	60,483	17,813	78,296	0.0

The Coke Company, then has as a necessity been concentrating on the foundry business and hopes to build its foundry coke sales back to the 250,000 ton level of the better years of the last decade.

With reduced coke production and operation on foundry coke, the Coke Company has been unable to produce the minimum contracted quantity of 60,000 therms per day of coke oven gas. Under the agreement between the Gas Company and the Sewerage Commission for the sale of the coke oven gas, the Gas Company has been required to make up this deficiency in coke oven gas by supplying higher cost natural gas, and since the Gas Company has sustained damages, it has had to enforce the minimum delivery

provisions of the Coke Oven Gas Contract and charge the Coke Company with the added cost of supplying natural gas which presently costs about 3.75¢ per therm. At present production rates of 23,000 therms per day this added charge is costing the Coke Company about $60,000 annually (37,000 therms deficiency x 365 days x $0.0045).

The Gas Company has entered into a new contract with the Sewerage Commission as of May 1, 1959 (subject to approval of the Wisconsin Public Service Commission) which, upon such approval, will terminate the old contract. This new contract will place the Sewerage Commission on a large volume rate schedule pricing heat units irrespective of the type of gas supplied so that there will no longer be any necessity to charge the Coke Company for the added cost of natural gas used to make up deficiencies in coke oven gas production below 60,000 therms per day.

The Gas Company proposes to ride out the Coke Oven Gas Contract until it terminates September 1, 1960, under which it pays the contract price amounting to about 3.3¢ per therm plus the annual standby fee of $100,000.

After the Coke Oven Gas Contract expires, the Gas Company proposes to buy surplus coke oven gas without a contract in the quantities and at the times that it is available at the heat equivalent of natural gas received from Michigan Wisconsin which is presently 3.75¢ per therm. The Gas Company does not propose to renew the standby arrangement.

Coke Oven Gas Yield:

The shift from furnace to foundry coke has required a shift in operation. While furnace and domestic coke can be produced with a coking time as short as 17 hours, high quality foundry coke requires a coking time of about 30 hours. Since plant capacity is reduced in inverse proportion to the coking time, maximum plant capacity producing foundry coke is 1600 tons per day of coal charge.

The Coke Company operates all of its ovens at all times regardless of the amount of production desired and regulates the amount of production by adjusting the coking time. Accordingly, the coking time is set by the amount of production desired and not by quality requirements other than for the minimum coking time needed to produce quality foundry coke. For this type of operation with an average coal charge of 2,000 ton the daily coke production is related to coking time as follows:

C = Coal Charge in Tons per day

T = Coking Time in Hours

$$C = \frac{2000 \times 24}{T} = \frac{48,000}{T}$$

The attached Chart No. 1 shows actual plant coal charge for various coking times. Over the past ten years the average coking time has been increased from about 24 hours to 48 hours.

Since the production of coke oven gas from a charge declines rapidly after about 20 hours, while the requirements for coke oven gas for underfiring fuel continues for the full period of coking, the net production of coke oven gas is less at longer coking times. Radiation heat losses from the ovens and the impracticability of continuously adjusting the firing to individual ovens results in increased consumption of coke oven gas with increased coking time. Further, the longer coking times give more time for flue gas to leak into the ovens which dilutes the coke oven gas with carbon dioxide and nitrogen thereby reducing the heat content per cubic foot.

The attached Table No. 1 shows by months the coal charge by types and times of coking time along with surplus coke oven gas production, heat content and specific gravity. The attached Chart No. 2 based upon these data shows the decline in net coke oven gas production and the decline in heating value with increases in coking time for the plant.

The attached Table No. 2 shows how the composition of the coke oven gas varies with coking time. The effect of flue gas leakage is indicated by the substantial increase in nitrogen content for the longer coking time.

In order to produce the minimum quantity of coke oven gas of 60,000 therms per day, specified in the Coke Oven Gas Contract, the plant would have to operate on a 23-hour coking time charging 2100 tons of coal per day. At this condition

the net coke oven gas production would be 28 therms per ton which is comparable to the production obtained by other plants in the industry. This condition is only possible when running to produce a substantial tonnage of furnace coke and there has not been a year since entering into the Coke Oven Gas Contract that the market for furnace coke has been sufficient to permit production of 60,000 therms per day of coke oven gas.

At present operating rates of about 1000 tons per day with a 48-hour coking time, the plant produces about 23,600 therms per day of net coke oven gas or 23.5 therms per ton.

The Coke Company anticipates markets which will require running at an operating rate of 1350 tons daily, starting in September, and at this rate the coking time would be 36 hours and gas production would be about 32,400 therms per day. At the maximum capacity of the plant when running for foundry coke of 1600 tons per day of coal charge with a coking time of 30 hours, the maximum coke oven gas production that can be expected is about 42,700 therms per day.

The amount of this coke oven gas that would be available for sale depends upon whether the gas is fired in the boilers and whether electric power is generated or purchased.

The following tabulation gives the reductions that could be made at three plant operating rates in the amount of power generated, steam produced, and gas fuel fired by purchasing power.

Operating Rate - Tons per Day Coal	1000	1350	1600
Annual Power Requirement - KWH	7,350,000	7,960,000	8,390,000
Less Power Purchased - KWH	2,000,000	2,000,000	2,000,000
Power Presently Generated - KWH	5,350,000	5,960,000	6,390,000
Possible Reduction in Generation-KWH (1)	4,750,000	5,360,000	5,790,000
Increase in Power Purchased-KWH (2)	5,280,000	5,950,000	6,430,000
Annual Reduction in Steam if Power is purchased - M. lb.	150,000	167,000	184,000
Annual Reduction in gas Fired if Power is purchased - Therms	2,130,500	2,370,600	2,608,800

Note (1) - Some 600,000 KWH annually can be generated on surplus process steam during times when the ammonia concentration plant is down, and would not require purchase.

(2) - Increase in power purchased is greater than the reduction in power generated because of 90% rectifier efficiency.

The attached Table No. 3 gives an estimate of the net surplus coke oven gas that will be available by months at three operating rates of 1000, 1350 and 1600 tons of coal charge per day if (a) coke oven gas is not fired in the boilers, (b) if coke oven gas is fired and electric power is generated, and (c) if coke oven gas is fired and electric power is purchased. The average day net surplus coke oven gas available under these conditions is summarized as follows:

	Average Daily Therms of Coke Oven Gas for Daily Operating Rates of:		
	1000 tons	1350 tons	1600 Tons
Surplus if Not Fired	23,600	32,400	42,700
Surplus if Fired with Electric Generation	300	5,700	14,200
Surplus if Fired with Power Purchased	6,150	12,200	21,300

While there is a net surplus of coke oven gas production over a year there would not be sufficient gas during the five winter months to meet all boiler fuel requirements when operating at the 1000 ton per day coal charge rate and producing power. These monthly deficiencies are shown in attached Table No. 3. The source of natural gas supply to the plant should be maintained to provide make up fuel during such periods of deficiency in coke oven gas for firing and for emergency purposes.

Economics of Standby Operation:

On the books of the Coke Company the Producer and Petroleum Plants are charged with actual cost expended on the plants and with an allocation of costs of other departments. The attached Table No. 4 gives a statement of costs for the year 1958 which were charged to the Producer and Petroleum Plants on the books along with an estimate of the actual cash costs that would not be incurred if the plants were dismantled.

Out of the $84,035 charged to the plants on the books only about $32,500 would be actually saved by abandoning the facilities. About two-thirds of saving would be in property taxes and insurance.

Part of the time of certain supervisory and operating personnel (1/2 to 2 hours per day) is charged to the plants. Abandonment of these facilities would save this time but there would not be any reduction in costs. Similarly, there would be certain savings of repair labor fractional hours but no personnel would be eliminated.

Eight operating personnel receive from 10¢ to 49¢ per hour above certain base rates for standing ready to operate these plants and an engineer devotes a substantial portion of his time to these plants. These costs amounting to $5,550 annually which are carried under "idle time" would be saved by abandoning the facilities.

Certain operating supplies, repair materials and a portion of the allocated costs of the service departments would be saved. Depreciation is not an item of saving since any remaining book value of the facilities not depreciated when the plants are abandoned and dismantled ($82,963 as of December 31, 1958) would be charged against surplus as an abandonment loss. Since the major part of the labor expense is on a part-time fractional hour basis so that these employees would not be eliminated and since certain allocated costs of other departments would not actually be saved, the actual cost attributable to the Producer and Petroleum Plants is about $32,500 annually. The Coke Company profits from the $100,000 standby fee.

OTHER PLANT OPERATIONS

Operating Practices:

The plant is operated so that desired throughput is obtained by adjusting the coking time. At the lower throughputs and longer coking times coke oven gas yields are reduced and carbon which normally seals the refractory is burned out of the ovens so that flue gas leaks into the coke oven gas (see Chart No. 2 for effect upon BTU content). Consideration was given to the economics and practability of banking one battery of ovens so that the remaining three batteries could be operated on a faster coking schedule. Decreasing the coking time would improve coke oven gas yield and would increase carbon on the walls of the ovens.

Fuel required to bank the one oven battery shut down would be about 10% of that required for coking and hence a substantial volume of fuel would be used to keep the battery warm. No saving is made in man power since the same number of ovens must be pushed in a given period and the increase in coke oven gas production is offset by the fuel required to keep the one battery warm. While more frequent pushing of the ovens in operation, maintenance expenses would be expected to increase and accordingly it is indicated that the present method of operation is to be preferred.

It is suggested that the operators of the plant experiment to produce foundry coke pushing warmer without changing its quality in an effort to seal the walls of the ovens more effectively with carbon.

With the procedures employed at the plant a good coke yield approaching 80% of coal charged has been consistently obtained. This yield is above industry average. Coke quality also has been above that of the general industry and the yields of the larger sized foundry and furnace coke have been good, in the range of 72%, further indicating the quality of operation. Attached Table No. 5 shows the production of coke from coal and the production of the larger foundry and furnace cokes out of total coke produced.

At the present throughput of about 1000 tons per day with a coking time of 48 hours, the operating forces have been reduced to two shifts per day. Attached Table No. 6 gives the cost for operating labor with two shifts as compared to three for the present operating rate. Only the operation of the ovens and coke handling are affected by this type of operation. By using two shifts instead of three there is a reduction of twelve jobs and a monthly saving of $6,700 in direct labor costs exclusive of fringe benefits.

In addition to selling current production the plant is presently reclaiming foundry coke from stock to meet market requirements and certain of the personnel are worked overtime in connection with the reclaiming operation. Attached Table No. 7 gives

the cost of labor for the coke handling department for this two shift operation with overtime as compared to three shift operation which shows a direct labor saving exclusive of fringe benefits of some $3,800 a month.

Operation with two shifts does not necessarily of itself entail additional overtime work. The temporary reclaiming of coke from stockpile results in some overtime being paid to men who work on the two shift basis. During the first three months of 1959 overtime was also paid to men working on the rush completion of crushing and screening apparatus. Table No. 8 gives an analysis of man hours and cost for operation and maintenance for the year 1957 during which three shifts were worked and for the year 1958 during which two shifts were worked. During 1957 with three shifts, overtime pay ran about $4,300 per month or about 10¢ per ton of coal charged. During 1958 with two shifts, overtime ran about $2,500 per month or about 9¢ per ton of coal charged. Plant operating statistics do not indicate any excessive overtime as a result of the two shift operation and, in fact, indicate a reduction.

For low operating rates the two shift method of operation results in reduced labor costs and accordingly is desirable. The Company has been on a two shift basis since January, 1958 and at the present time proposes to continue to operate on this basis until capacity is increased to 1,350 tons per day in September of 1959, at which time it is planned to resume three shift operation.

In addition to the some $5,500 annually of standby or idle time as described in the previous section of this report under "Economics of Standby Operation", there appears to be a possibility of effecting further labor savings by consolidating certain of the foreman and assistant foreman job classifications. In other plants which have effected similar economies the duties being performed by some fifteen employees of this class have been consolidated to reduce the number of supervisory personnel.

The labor agreements between the Coke Company and the Unions is a better than average contract in the industry. Wage scales are not out of line and, in fact, are lower than in many plants, and operating restrictions though bothersome are not as severe as in other similar contracts in the industry.

The supervisory personnel at the plant are capable and experienced men doing a creditable job.

By-Product Yields:

While the yield of coke from coal is exceptionally good (in the range of 80%), the yield of coal chemicals from the antiquated recovery system is somewhat less than would be expected from the average coke plant. Comparative yields of coal chemicals are as follows:

	Coal Chemical Yields per Ton of Coal Coked	
	Coke Company Plant	Average Industry
Tar	6.9 Gallons	7.4 Gallons
Ammonia	3.9 Pounds	6.5 Pounds
Aromatics	2.3 Gallons	2.9 Gallons

Part of the lower by-product yield, particularly in the case of ammonia is the result of the higher percentage of low volatile coal used in the manufacture of foundry coke, while the remainder is the result of low efficiency of the recovery equipment.

The revenue from these by-products though substantial in dollar amount is a relatively small proportion of total revenue as indicated by the following revenue figures, and the Coke Company has not felt justified in the face of decreasing by-product prices in revamping, or in cases, repairing recovery equipment.

Year	Revenue from Coal Chemicals	Total Revenue	Per Cent of Revenue from Coal Chemicals
1952	$ 1,123,798	$ 11,849,903	9.5%
1953	1,144,982	13,189,828	8.7
1954	636,849	6,335,250	10.0
1955	862,265	11,855,494	7.3
1956	878,355	10,501,104	8.4
1957	834,335	10,271,107	8.1
1958	582,509	7,678,566	7.6
(3 months) 1959	138,800	2,387,777	5.8

The economics of by-product recovery were reviewed and based on actual costs it is indicated that recovery is only slightly profitable to marginal. On the basis of costs actually incurred and allocated against the recovery units the recovery operations would not appear economic, however, the abandonment of these operations would not result in the saving of the book costs that are presently charged to the operations.

In the case of light oil recovery the gas must be cleaned of naphthaline to prevent plugging in gas mains and accordingly certain minimum expenditures are required. In the case of ammonia the recovery unit could be shut down if it were desired, and the ammonia liquor diverted to the sewage plant as has been done in the past during periods of downtime on the ammonia recovery unit.

The trend in prices obtained for by-product coal chemicals is shown in Attached Table No. 9. Since 1952 the price of tar and ammonia has increased while the price of light oils has decreased markedly. As the market for these by-products changes and as major maintenance expenditures or capital additions to the by-product recovery system are required an analysis should be made to determine the economic desirability of continuing by-product recovery.

FIRING ALTERNATE FUELS AND POWER GENERATION

The boiler house is equipped with 4- 600 HP and 4 - 400 HP boilers presently equipped for firing fuels as follows:

Boiler Number	Boiler Horsepower	Fuel
1	600	Gas or Coal
2	600	Gas or Coal
3	600	Coke
4	600	Coke Breeze and Coal
5	400	Coke Breeze and Coal
6	400	Coal
7	400	Coke Breeze and Coal
8	400	Coal

In the past there has been little market for coke breeze, and this material has been mixed with 25 to 30 per cent coal and fired for steam generation. Coal and natural gas have been used to make up the remaining heat requirements.

Coke breeze has been valued at its heating value of about 5/6 of that of coal or $6.17 per ton. Recently, a good and apparently continuing market is developing for coke breeze at about $8.00 per ton for use in the benefaction of taconite iron ores, and accordingly coke breeze has a greater value for sale than for fuel. The Coke Company has gradually been reducing the tonnage of coke breeze and coal fired and has replaced these fuels with natural gas. Presently, no coke breeze is being fired.

While coke oven gas has a sales value of about 3.3¢ per therm, any of this gas used in the past has had to be replaced by natural gas at Michigan Wisconsin prices (presently 3.75¢ per therm) for delivery to the Sewerage Commission. Accordingly, coke oven gas has had a value to the Coke Company of 3.75¢ per therm. It is difficult to understand why the Coke Company would buy natural gas at 4.7¢ per therm when it could burn its coke oven gas at 3.75¢ per therm.

Now that the Coke Company is not to be required to pay increased natural gas prices for coke oven gas production below 60,000 therms per day, coke oven gas has a lower value of 3.3¢ per therm and there is even more advantage to firing coke oven gas instead of natural gas.

Solid Fuels vs. Gas: As previously noted the Coke Company is presently firing coal and natural gas. In order to indicate the relative economics of firing various fuels, the actual plant costs which vary with the type of fuel used have been analyzed. Since the amount of steam generated, and hence costs, depend upon whether electric power is generated or purchased, these costs which vary with the type of fuel fired have been considered both for generating and for purchasing electric power along with the costs which vary with the generation or purchase of power.

The attached Table No. 10 gives a comparison of the costs which vary with the type of fuel fired and with electric generation for (a) the firing of solid fuels only, (b) the firing of both solid fuels and natural gas and (c) the firing of gas only at various prices, all for the anticipated operating rate of 1350 tons per day of coal charge.

The quantity of steam, electric power and fuel required are shown at the top of the table. Steam and total power requirements are taken from plant operating data since 1952 as shown on attached Chart No. 3. Recently about 2,000,000 KWH have been purchased annually, and this quantity was taken as the amount to be purchased if electric generation is to be continued. If electric power is to be purchased it is estimated that surplus steam will be available on weekends when the ammonia concentration plant is down, to generate 600,000 KWH annually and purchased power would be reduced by this amount.

Fuel requirements to generate steam in the existing boiler equipment are taken at the following plant experience figures:

Fuel	Steam Generated
Coke Breeze	10,000 lbs. per ton
Coal	12,000 lbs. per ton
Gas	70.5 lbs. per therm

The costs which vary with the type of fuel fired are the fuel cost and the cost of boiler house operation and repair. Fuels are taken at their present values of $7.40 per ton for coal (and coke equivalent), 3.3¢ per therm for coke oven gas and 4.7¢ per therm for natural gas. In the columns dealing with gas firing the total costs are also shown for gas values of 3.75¢ and 4.7¢ per therm. Boiler house incremental operating and repair costs are taken from plant experience as shown on attached Chart No. 4.

The costs which vary with electric generation are the cost of power and power house incremental costs. Electric power at present consumption levels costs about 1.7¢ per KWH. The Wisconsin Electric Power Company prepared an estimate of 1.4¢ per KWH for purchase of full plant requirements. Power house incremental costs are taken from recent experience.

The costs which vary with the type of fuel fired and with electric generation are summarized from Table No. 10 as follows:

	Annual Variable Costs	
	When Generating Power	For Purchasing Power
Solid Fuel Firing	$ 612,000	$ 539,000
Solid Fuel and Natural Gas Firing	561,000	495,000
Gas Firing for Gas @ 3.3¢ per therm	378,000	356,000
@ 3.75¢ per therm	425,000	389,000
@ 4.7¢ per therm	514,000	459,000

In order to fire coke oven gas it will be necessary to change the orifice sizes in the burners in Numbers 1 and 2 boilers and install gas burners in Numbers 3 and 4 boilers. The estimated costs of this conversion including the removal of the stokers in Numbers 3 and 4 is $60,000.

The payout of this conversion cost by firing coke oven gas instead of solid fuels and natural gas is very attractive as follows:

	With Power Generation	For Purchasing Power
Variable Costs from Table No. 10:		
For Firing Solid Fuels and Natural Gas at present	$ 561,000	$ 495,000
For Firing Coke Oven Gas at 3.3¢ per Therm	378,000	356,000
Gross Saving	183,000	139,000
Less Income Taxes	96,000	72,000
Net Saving	$ 87,000	$ 67,000
Conversion:		
Cost	$ 60,000	$ 60,000
Payout	0.7 years	0.9 years

Since the payout is prior to the termination of the Coke Oven Gas Contract, a price of 3.3¢ per therm is taken for coke oven gas.

It is quite clear that the Coke Company should stop firing all solid fuels and natural gas and fire its own coke oven gas, whether or not electric power is generated or purchased. Savings over the present method of operation are estimated at $183,000 annually and at $139,000 annually if electric power is purchased.

Power Generation vs. Purchase: The power house is equipped with very old equipment to produce 250 volt D.C. power as follows:

Generator Number	KW	Drive	Energy Source
1	200	Engine	150 lb. Steam Exhausting to 150 or 3 lb.
2	200	Engine	150 lb. Steam Exhausting to 150 or 3 lb.
3	200	Engine	150 lb. Steam Exhausting to 150 or 3 lb.
4	(a)	Engine	150 lb. Steam Exhausting to 150 or 3 lb.
5	600	Turbine	150 or 3 lb. Steam Condensing
6	600	Turbine	150 or 3 lb. Steam Condensing
7	1000	Motor-Generator	Purchased Power
Total -	2800		

Note (a) - This 300 KW unit broke down and is out of service.

Because of the ease of control the Coke Company uses the motor generator set to take the main swings on plant power requirements. Accordingly, purchased power supplies peak load requirements and minimum power is purchased.

Rectifier equipment is required to convert purchased power into D.C. for plant use. In order to meet peak load demands some 1750 KW of rectifying capacity should be provided. The cost of a 1000 KW and a 750 KW mercury arc rectifier is estimated at $200,000 installed, based on advice from Allis-Chalmers Manufacturing Company. The payout of this investment depends upon the type of fuel and its cost as shown in the following tabulation:

Variable Costs from Table No. 10:	Natural Gas and Solid Fuel Firing	Firing with Gas 3.3¢/Therm	Firing with Gas at 3.75¢/Therm	Firing with Gas 4.7¢/Therm
With Power Generation	$ 561,000	$ 378,000	$ 425,000	$ 514,000
For Purchasing Power	495,000	356,000	389,000	459,000
Gross Saving	66,000	22,000	36,000	55,000
Less Income Tax	32,000	8,000	16,000	26,000
Net Saving	$ 34,000	$ 14,000	$ 20,000	$ 29,000
Conversion:				
Cost	$ 200,000	$ 200,000	$ 200,000	$ 200,000
Payout	5.9 years	14.2 years	10.0 years	6.9 years

The payout of the investment to permit purchasing electric power is not particularly attractive for the present operation when firing solid fuels and natural gas, and is particularly unattractive when firing coke oven gas at 3.3¢ per therm.

Instead of going to purchased power at this time it is believed that the motor generator set should be operated at its maximum continuous load capabilities (instead of for peak load) so as to purchase a maximum amount of power and minimize the amount generated. With this method of operation, a saving in boiler house costs will be realized without any added capital investment.

When coke oven gas is valued at the price of natural gas delivered by Michigan Wisconsin, the conversion becomes somewhat more attractive and if the advent of Canadian gas further increases the price of Michigan Wisconsin gas, and hence the value of coke oven gas, the economics of the conversion improve further. As the value of coke oven gas increases and as absolute need to replace or major repair present generating equipment arises, consideration can then be given to making the investment required to permit purchasing electric power. Other conditions at that time can also be taken into consideration.

MAINTENANCE AND PLANT CONDITION

As a matter of policy, the plant has for some time been undertaking only day to day maintenance and has deferred a substantial amount of maintenance required to keep the plant in continuing operating condition. In past years some $1,000,000 annually or about $1.40 per ton of coal charged was expended on maintenance. In recent years this has been reduced to some $500,000 annually or about $.80 per ton. This procedure has resulted in cash savings in the past.

From observations of plant condition it is indicated that if operation is to be continued for more than a few years an additional expenditure in excess of the amount planned to be spent for maintenance must be made. An additional 60¢ per ton or $250,000 annually is estimated to be required for continued operations.

The ovens themselves are of principal importance since if allowed to deteriorate their replacement could not be justified under present economic conditions. The operating management is giving careful attention to this equipment but is limiting repairs to a necessary minimum.

As stated previously herein the concentration of ammonia and the fractionation of light oil by-products is marginal and rather than maintain these facilities in top condition it is

believed desirable to continue recovery of these products until major replacement of facilities is required at which time abandonment should be considered. This same consideration applies with respect to power generation.

SECTION 2 rev

THE FUTURE SALE OF COKE OVEN GAS BETWEEN

THE COKE COMPANY AND THE GAS COMPANY

PRIOR TO TERMINATION OF THE COKE OVEN GAS CONTRACT

The Gas Company plans to "ride out" the Coke Oven Gas Contract until it terminates September 1, 1960. This is a sound plan and appears to be the best arrangement possible, both for the Coke Company and for the American Natural Gas Company system. Under the new arrangement between the Gas Company and the Sewerage Commission in which there is no longer any necessity to charge the Coke Company for the added cost of natural gas used to make up deficiencies in coke oven gas production below 60,000 therms per day, the Coke Oven Gas Contract can operate to the benefit of the Coke Company regardless of the low price established for coke oven gas in this contract.

During the period until termination of the Coke Oven Gas Contract some 18 months hence, coke oven gas will be priced at the heat equivalent of coal presently about 3.3¢ per therm. If the contract were cancelled now, coke oven gas could be priced at its value equivalent to natural gas delivered by Michigan Wisconsin which is presently 3.75¢ per therm. It has been recommended previously herein that the Coke Company burn its coke oven gas under its boilers so that a minimum volume of coke oven gas would be sold. If the Coke Company sells net surplus gas in the amount of 6,000 therms per day for the next 18 months (3,300,000 therms), the loss in revenue to the Coke Company for sale at 3.3¢ per therm as against 3.75¢ per therm is only about $15,000.

Since this loss in revenue to the Coke Company represents a gain in revenue to the Gas Company there is no net effect upon the American Natural System. As previously noted herein, the actual cost of holding the producer and petroleum plants for standby is about $32,500 annually, so that net cash of some $67,500 annually or over $100,000 during the next 18 months will be obtained under the standby arrangement.

Accordingly, the Coke Company and the American Natural system will benefit during the next 18 months by keeping the Coke Oven Gas Contract in effect, until it expires.